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INTERNATIONAL COOPERATION IN THE PEACEFUL USES OF OUTER SPACE: ACTIVITIES OF MEMBER STATES

Note by the Secretariat

Addendum

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INTRODUCTION

1. Documents A/AC.105/567 and Add.1 and 2 contain information received from Member States as of 15 December 1993 on the following topics, pursuant to a recommendation made by the Committee on the Peaceful Uses of Outer Space at its thirty-sixth session:[1]

(a) Those space activities that were or could be the subject of greater international cooperation, with particular emphasis on the needs of the developing countries;

(b) Spin-off benefits of space activities.

2. The present document contains information on those topics that was received from Member States from 15 to 23 February 1994.

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[1] Official Records of the General Assembly, Forty-eighth Session, Supplement No. 20 (A/48/20), para. 122.

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REPLIES RECEIVED FROM MEMBER STATES*

GERMANY

[Original: English]

Germany regards the peaceful uses of outer space and the development of space technology as tasks, which require international cooperation to achieve the greatest effect. Participation in bi- and multilateral programmes and projects is therefore the centrepiece of German space activities. A major premiss is that the benefits of the use of outer space should be spread as widely as possible. To that end, Germany is actively involved in a number of United Nations space related activities and is willing to collaborate creatively and innovatively in the United Nations Committee on the Peaceful Uses of Outer Space.

The following report contains in its first section an outline of the organizational structure of German space management. The second section deals with international activities subdivided into participation in ESA, the UN and other international governmental and non-governmental organizations. The third section gives an overview of activities in the German space programme with bi- or multilateral scope as well as bilateral cooperation with developing countries.

I. ORGANIZATION

An assessment of the management structure for space activities was conducted in Germany during the second half of the 1980s after the political decisions for European autonomy regarding space flight issues were made at ESA's Ministerial Council in Rome in 1985 and the adoption of the Long-Term Plan by the ESA Ministerial Council at The Hague in 1987. The growing international and national commitments by Germany then resulted in the Cabinet decision to create a new management structure capable of handling these tasks, i. e., a Cabinet Space Committee, a State Secretaries' Space Committee and the German Space Agency DARA (Deutsche Agentur fiir Raumfahrtangelegenheiten GmbH).

The Cabinet Committee on Space Activities prepares Government space policy decisions, as well as fundamental strategies and planning aspects. It advises on the allocation of the federal budget. Funds are made available to DARA from the responsible ministries. The Cabinet Committee's activities are prepared by the State Secretaries' Committee on Space which is also responsible for coordinating the space interests and activities of the various ministries involved. It sets goals and guiding principles for DARA, which was established on 26 April 1989. DARA is chartered by special federal law conferring governmental responsiblities upon it. It has the legal status of a company with limited liability. The Federal Government is the sole shareholder. DARA's Supervisory Board consists of representatives of the German Federal Government as well as industry and science. The work of DARA is based on efficient business management, guaranteeing flexibility and mobility as well as the desired proximity to industry and science.

As the central management organization for the coordination of German space activities, DARA has to draw up plans for German space policy for approval by the Federal Government, which includes: planning German participation in international programmes and projects; planning national projects with due consideration for European, bilateral and multilateral programmes; technological, economic and financial recommendations, analysis and project proposals.

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*The replies are reproduced in the form in which they were received.

Furthermore, DARA must implement and manage the German space programme and award contracts and grants to industry and science. In particular, this consists of advising and assisting the federal ministries and public institutions involved, as well as coordinating activities with industry and scientific institutions; promoting, directing and monitoring projects, and evaluating their results; planning and coordinating use of facilities; initiating and promoting commercialization; allocating and contracting funds from the space budget in accordance with its statutory authority and determining financial requirements.

Finally, DARA represents German space interests in the international arena, particularly vis-à-vis ESA by representing the German position within the committees of ESA and other international organizations (in so far as this is not done at the ministerial level for political reasons); participating in drawing up and controlling ESA programmes; and representing the German position in the implementation of multilateral and bilateral agreements. Within this framework, numerous project agreements are executed with DARA's partner organizations, such as NASA, CNES, the Russian Space Agency RKA and others. An inter-agency agreement with RKA was signed on 1 March 1993 and standing working-groups on different topics have been institutionalized between DARA and NASDA. Regular meetings are held between DARA and the space agencies of the U.S., France, Russia, Japan, the Netherlands, Sweden, Spain, Italy, Austria, Norway, the UK, and Canada.

A Technical and Scientific Advisory Board ensures that the respective requirements are taken into account. Several ad hoc advisory committees are established for specific topics. Currently, DARA with its 270 employees manages approximately 500 projects and studies, and awards contracts to about 130 scientific institutes and industrial companies.

In close cooperation with DARA, the primary responsibility of the German Aerospace Research Establishment DLR (Deutsche Forschungsanstalt für Luft- und Raumfahrt e. V.) is to execute research elements of the national programmes and some of the German contributions to the European large-scale space projects. With more than 4400 employees, including some 1500 scientists, DLR ist the largest research establishment for engineering sciences in the Federal Republic of Germany. It's research centres are located in Berlin, Braunschweig, Göttingen, Cologne, Oberpfaffenhofen and Stuttgart. Together with DARA, DLR runs two liaison offices in Paris and Washington. Besides Astronautics DLR focuses on Aeronautics and Energy Technology.

DLR's scientific-technical expertise lies with the 23 institutes of its five scientific Research Departments: Telecommunications Technology and Remote Sensing, Materials and Structures, Energetics, Fluid Mechanics, Flight Mechanics/Guidance and Control Test facilities include subsonic-to-hypersonic wind tunnels, rocket propulsion test stands, mobile launch facilities, spacecraft TT&C stations and space simulators. For space missions, particularly those for Spacelab D2, Columbus and Eureca, DLR operates Crew Training Complex, Microgravity User Support Centre, German Space Operations Centre, Manned Space Laboratories Control Centre, German Remote Sensing Data Centre.

The majority of DLR's research programmes/projects are executed in an international context, that means multilaterally within ESA and EU Programmes and bilaterally. Cooperation agreements exist with nearly all EU and ESA member countries, with Russia and Eastern countries and with developing countries such as Argentina, Brazil, China, Chile, India and Indonesia.

The DLR Research Centre in Oberpfaffenhofen is involved in environmental monitoring by means of sensor development and operation, aircraft campaigns, mission planning and control, and data collection, pre-processing and archiving. This is done in cooperation with national agencies (DARA) or ministries (Federal Minstry for Research and Technology (BMFT), Federal Ministry for Environment, Nuclear Safety and Preservation of Nature (BMU)) and international space agencies (ESA) and their relevant branches (ESRIN). Furthermore within the context of specific projects, a close cooperation has also been established

with Research Centres of the CEC (JRC Ispra) and with remote sensing organizations and space agencies of other countries (NASA, CONAE, CNES, CCRS, INPE, INTA, ISRO, LAPAN).

The German Remote Sensing Data Center DFD (former name: Applied Data Techniques Division) at the DLR Research Center Oberpfaffenhofen was founded in 1980 as part of the DLR Scientific-Technical Facilities. It concentrates all tasks related to information handling/processing for remote sensing and Earth Observation (EO) applications. Under contract of ESA the DFD has implemented and is now operating the German Processing and Archiving Facility D-PAF for ERS. The D-PAF is part of the ESA ground segment for the acquisition and offline processing of ERS payload data. It includes the generation of standard and special products and their subsequent distribution to users. Additionally the DFD operates an 8-m mobile ERS-1 receiving station, is acting as national archive and processing facility for all kinds of EO data (globally and locally distributed) and provides and intelligent user interface to these data and their data products.

II. INTERNATIONAL ACTIVITIES

A. Participation in the European Space Agency

Space research and space technology have been actively promoted in Germany since 1962. Western European countries recognized that space research should be more effectively conducted as a common effort and in the context of international cooperation. They joined forces in 1964 in the foundation of the scientific organisation ESRO and the launcher development organisation ELDO. These two organisations were merged in 1975 to create the European Space Agency, ESA, an organisation whose activities are oriented to purely peaceful purposes. Owing to the size of the Gross National Product, Germany has to make the largest single contribution to ESA's mandatory activities. Apart from its role in ESA, Germany is involved in bilateral and multilateral cooperation with such partners as the U.S., but also Japan and the CIS.

German space objectives will continue to be realised through participation in and, where appropriate, assumption of management responsibilities for programmes and projects in an international context, but particularly through its role in the drafting and implementation of ESA's long-term European space plan. On the other hand, Germany seeks extensive correspondence in the national programme in order to ensure that the country has all the requisite competence and efficiency for full participation in international coooperation and in the utilization and application of the results of space research.

Almost two thirds of Germany's space budget are channelled through programmes of the European Space Agency. German participation in ESA covers all important fields of space activities:

- extraterrestrial science in the field of astronomy/astrophysics and solar-terrestrial relations with the disciplines aeronomics (physics of higher spheres) and physics of magnetospheres and plasma,

- research under space conditions for material science, biology, and medicine with manned and unmanned spaceflight operations,

- earth-oriented research with regard to the management of natural resources, the atmosphere, the oceans, and the ice-covered areas of the earth,

- development of telecommunication satellite systems and enhancement of techniques for the utilization of navigation satellite systems,

- development of orbital infrastructure, space transportation systems and corresponding ground infrastructure,

- preparatory work for the utilization of orbital systems, as satellites, platforms, and laboratories, improvement of the ARIANE carrier technology, development of basic technologies and also exploration of industrial and commercial use of space technology.

The current ESA programme will lead to a broadening of European space activities in that it envisages a contribution to the global space station, the utilization of the Russian space station MIR as a precursor activity to the future use of the global space station, the development of enhanced transport capacity, and the prospected data relais satellite system.

Examples of major German participations and contributions to ESA programmes of actual relevance are described in the following paragraphs.

The comet probe GIOTTO is best known for the spectacular pictures it radioed back to Earth during its extremely close fly-by of Halley's comet in 1986, when the distance between the probe and the comet was a mere 605 kilometers. The optical camera instrument was provided by German scientists. The probe's main mission was to observe the nucleus of the comet by means of special cameras and to collect data on the coma, i.e. the envelope of gas and dust surrounding the nucleus. Since the succesful completion of this mission, GIOTTO has been in hibernation in an elliptic orbit around the sun, i.e. in a stand-by position. The probe was reactivated in February 1990 and its trajectory was changed to arrange an encounter with comet Grigg-Skelljerup which it passed on July 10, 1992. Again outstanding data were sent to Earth and are being processed presently.

The solar satellite ULYSSES was launched in October 1990 with the Space Shuttle, which transported the space probe to its point of departure on a flight trajectory which can only be achieved by means of powerful booster rockets and a sophisticated swing-by maneuver round the planet Jupiter: an orbit around the poles of the sun. The main objective of the mission is the scientific study of solar wind and the sun's magnetosphere, the analysis of interplanetary and interstellar gases and particles, and the measurement of unified radio and plasma waves. German scientists provide several of the payload instruments and German industry figured as main contractor for spacecraft development. ULYSSES passed Jupiter in 1992, left the ecliptic plane and is now on its way around the poles of the sun.

The objective of the European EURECA Programme (European Retrievable Carrier) is to dispose of a free-flying re-usable research laboratory for long-term missions. Besides its utilization for experiments in the fields of life science and crystal growth under microgravity conditions (all of them being part of any exploitation of in-orbit infrastructure), it allows Europe to gather experience in operation and exploitation of orbital infrastructure. Launched in July 1992 by the Space Shuttle and put into Low Earth Orbit, Eureca's propulsion system lifted the platform into a higher orbit from where it returned to the Shuttle orbit after 11 months in August 1993 to be captured and taken back to Earth. The mission was performed successfully and the experiment data are presently being evaluated. Germany participated in this mission with 18 experiments, studying various effects of microgravity, vacuum, and cosmic rays on material and biological probes. Germany is the system leader in this programme and contributes 54% to the total financing.

In Earth Observation the success of the ERS-1 (European Remote Sensing Satellite) has to be highlighted. This satellite was built under German system leadership. It is operational in all weather conditions and allows measurements with its microwave/radar sensors through cloud-layers day or night. ERS7-1 is dedicated to research in oceanography and ice observation and its data gathered up to now give new and valuable inputs to global climate change models by describing the interactive relations between the atmosphere and oceans. The experience which is gathered during the operation of ERS-1 is of great benefit for many scientists and users from different countries in various research disciplines and application fields. It will be expanded during the follow-on mission ERS-2 from 1995 onwards and will prepare scientists and

users for the utilization of the large European polar platform mission ENVISAT which is scheduled for a launch in 1998.

The weather satellite METEOSAT represents a classic example of the application-oriented utilization of space research. This system, which was developed within the ESA programme with German participation, is part of an internationally coordinated satellite-observation programme in the field of meteorology involving American, Japanese, and European satellites, and systems of the CIS. A shining example of international partnership is given through the fact, that the European organization EUMETSAT moved its spare satellite METEOSAT-3 from his original position to a new position farer West in order to close a gap which was opened by the failure of the American weather satellite GOES-W. The METEOSAT-system will be replaced by a 2nd generation system as successor in 2000. Two satellites of the present METEOSAT configuration will fill the time gap in between, the first of both having been started in November 1993. Also planned for a start in 2000 is the polar orbiting platform METOP-1, the first of a series of European polar missions dedicated to weather prediction and climate research. The METOP satellites will be in complement to the American NOAA weather satellites.

Since 1978, ESA has a presence of telecommunication satellites in the geostationary orbit around the Earth with its experimental OTS (Orbital Test Satellite) satellites and - later - with its preoperational ECS (European Communication Satellite) and MARECS (Maritim ECS) satellites that have given Europe independence in the vitally important sector of telecommunications. Today, with its Olympus satellite and by studying advanced telecommunications systems, ESA is taking a hand in shaping the telecommunications of the future. Germany has 30 years' experience in this special field of space utilisation and participates in the ESA telecommunication projects with important technology contributions. Major projects of the future are the experimental data relais satellite ARTEMIS, which will be launched in 1996, and the two operational DRS satellites to be launched at the end of the century. With their enhanced data relais capabilities, the latter two satellites are important contributions to the global space station and other in-orbit infrastructures like the polar orbiting Earth observation platforms.

With respect to space transport the main European Programme is the ARIANE launcher, which has been developed since the mid-seventies into a family of launch vehicles with different capabilities and various uses. Presently ARIANE covers more than 50 % of the commercial satellite launches and by the end of the century about 100 launches will have been made. ARIANE is continuously being further developed, the efforts currently aiming at model ARIANE-5, a rocket with increased payload capacity compared to its predecessor ARIANE-4, for multiple satellite launches and heavy and large payloads like the future polar platforms and unmanned or manned logistic modules for the Global Space Station. Germany participates with 22% in the ARIANE-5 programme.

Considering the future contribution of Europe to the Global Space Station, Germany, together with the other member states of the European Space Agency, is closely involved in the discussions with the other partners of the Intergovernmental Agreement on the Space station, the U.S., Canada, and Japan, as well as with the new partner Russia on the future scenario in an effort to define the best workshare in this fascinating project for peaceful use of outer space. Europe will contribute substantially to all three phases of the Global Space Station.

B. Participation in the United Nations

1. United Nations Committee on the Peaceful Uses of Outer Space

Germany has, since its accession to the United Nations, actively participated in the work of UNCOPUOS. During the 1980s and up to the most recent sessions of the Committee, the main emphasis was placed on the development of principles relevant to the use of nuclear power sources (NPS) in outer space.

Together with Canada, numerous working papers were prepared for the Committee session. The successful completion of a set of principles on NPS during the session of 1992 and its subsequent adoption in the General Assembly as UNGA Res. 47/68 of December 14, 1992 marks an important event in the history of German participation in UNCOPUOS.

This activity indicates Germany's willingness to participate in efforts to arrive at standards from which mankind as a whole will benefit. Another area where the responsibility for mankind's natural environment is the core of Germany's efforts is the space debris problem. For a number of years the German delegation has provided the Scientific and Technical Subcommittee with detailed reports on the research on space debris undertaken in Germany under the guidance of DARA.

2. United Nations Programme on Space Applications and other training and fellowship programmes

Within the framework of this programme the German Carl Duisberg Society (CDG), with support of ESA and ICIMOP, organized in October/November 1993 for the fifth time a Training Course on Remote Sensing Applications (to the Planning and Management of Environmental, Natural Resources and Physical Infrastructure). So far, these courses have taken place at Berlin and Potsdam. In 1993, this year's course for the first time took place in an Economic Region, namely in Kathmandu, Nepal, with particular stress on participation of ESCAP countries. This is not only a sign of German commitment to disseminating knowledge in the area of space applications to developing countries but is also a practical measure to enhance participation from countries in the different regions. It will soon be decided in which region the 1994 course will be held.

To mention explicitly one other activity in this field, Germany has in recent years supported the UN/ESA Workshops on Basic Space Science for Developing Countries (the last of which took place in Lagos in October 1993). These workshops are considered an effective way of spreading the knowledge in basic space science.

Complementary to these activities, Germany is following with interest the plans to establish regional Centres for Space Science and Technology Education in developing countries being prepared by OOSA's expert on space applications. A German expert participated in the evaluation mission to Africa, which took place in March/April 1993.

Besides German participation in United Nations activities, various other training and fellowship programmes relating to space applications exist at German institutions. DLR accommodated almost 50 foreign research scientists for under three months and more than 30 for over three months in 1992. The Agency for Technical Cooperation (Gesellschaft für Technische Zusammenarbeit (GTZ)) hosted, inter alia, training programmes abroad on remote sensing and invited scientists to conduct research work in Germany for up to three months. The German Academic Exchange Service (Deutscher Akademischer Austauschdienst (DAAD)) awarded fellowships for training in Germany in the areas of air and space medicine, aerospace science and technology. The Alexander von Humboldt Foundation also awarded fellowships. The Technical University at Braunschweig offers a complete training programme in space technology at the Institute for Space Flight Technology and Nuclear Reactor Technology. As is the case with other German universities, tuition is not charged. The University of Cologne offers a postgraduate doctoral programme to lawyers at the Institute for Air and Space Law, which is the oldest specialized institute of its kind in Europe. The programme is also open to lawyers holding foreign law degrees. Upon request, the doctoral examination can also be held in English.

All these programmes, even though they may not involve the United Nations Programme on Space Applications, parallel its activities in that they offer training opportunities which are open to researchers and scientists from developing countries.

The whole scope of German contributions to the space-related activities of the United Nations and its specialized agencies is contained in UN Doc. A/AC. 105/524 of December 14, 1992.
Germany is also active in IDNDR, which possesses a number of starting-points for space utilization.

C. Other International Activities

1. European Union

Following the adoption by the council of the Communication "The European Community and Space: Challenges, Opportunities and New Actions", the European Union decided to concentrate on the areas of earth observation (the EU is already the principal user of satellite data for its common policies like agriculture, fishery and environment), satellite communications (particularly in the area of regulation) as well as technology development and industrial policy.

The Commission has established a Space Advisory Group (SAG) for all space activities. This committee is composed of delegates of the member-states'ministries, the national space agencies (DARA for Germany) as well as ESA and the European user organizations. The SAG met for the first time in November 1993 and will in future review all important aspects of space activities including the consideration of space utilization for development aid projects.

2. Other International Organizations

Germany, through its respective ministries, is not only an active member of well-known international user-organizations like INTELSAT, Intersputnik, INMARSAT, EUTELSAT or EUMETSAT. Additionally, the German Space Agency DARA participates in a number of non-governmental international organizations.

First to be mentioned is the Committee on Earth Observation Satellites (CEOS). DARA will hold the presidency of CEOS during 1994 and will host its plenary meeting in September of that year in Berlin. DARA also attends the meetings of the Space Agency Forum (SAF), which is the offspring of the Space Agency Forum for the International Space Year (SAFISY), and it contributes to the activities of EURISY, the European organization for the International Space Year which is still active in a number of fields, with the accent on education. Finally it should be mentioned that DARA supports the International Space University (ISU) as a promising initiative for further space activities.

III. ACTIVITIES IN THE NATIONAL SPACE PROGRAMME WITH BILATERAL OR MULTILATERAL SCOPE

Programmes

Like that of many other nations, Germany's space programme has its roots in space science endeavours centring on an extensive sounding rocket activity beginning in the early 1960s. With Germany's participation in the European cooperative programmes of ESRO and ELDO, the predecessors of ESA, the perception evolved that a reasonable national programme would be a necessary accompaniment to international efforts. However, no purely autonomous large-scale activities were either planned or executed. As briefly mentioned in the introductory remarks, German space activities have from the beginning focused on international cooperation. Thus, Germany's first scientific satellite Azur was launched by the United States' NASA in 1969. Since then, a series of national projects has been executed in cooperation, primarily,

with the United States and France, but also with other European countries such as Sweden, Italy, the Netherlands, the United Kingdom and others. Partnership with the Commonwealth of Independent States and Japan is currently being intensified. Of special note is the fact that the space projects carried out jointly between the former German Democratic Republic and the former Soviet Union have been taken over to a certain extent by the German Government after reunification and have now been incorporated in an already existing agreement of cooperation between Germany and the Russian (former Soviet) Academy of Sciences. This agreement comprises about 50 projects in the different disciplines of space research and technology.

A large number of bilateral agreements on scientific and technical cooperation constitute the legal groundwork of German activities in space, including with such developing countries as Argentina, Brazil, China, India and Indonesia, among others.

Germany's space activities have been directed from the outset by the Federal Ministry for Research and Technology, the Bundesministerium für Forschung und Technology (BMFT) or its predecessors. Other BMFT-funded institutions dealing with space research are, e.g., the German Aerospace Research Establishment (DLR), the German Research Foundation (Deutsche Forschungsgemeinschaft (DFG) and the Max Planck Society (Max-Planck-Gesellschaft (MPG)). A major organizational change occurred in 1989 with the above-mentioned creation of the German Space Agency DARA, which assumed responsibility for the planning and management of Germany's national and international space programmes and for the representation of Germany's space interests in international relations, particularly regarding ESA. The national element of the space programme is conceived in particular as a supplement to participation in ESA programmes, as a framework for the preparation of German industry and scientific institutions for special domestic research and development and applications, and as a means of maintaining a competent role in European and other international programmes. National planning is in conformity with ESA's long-term plan up to the beginning of the next century and with the Governments's medium term financial planning covering a four-year financial planning period, currently up to 1997.

At present, the balance in financial terms between the national programme (which includes funding of DARA and partial funding of research establishments but excludes the Hypersonic Technology Programme) and Germany's contribution to ESA programmes has been set, with ESA programmes absorbing an average of 65 % of the total space expenditure, thus indicating Germany's conception of space issues as international cooperative endeavours. The proposed total annual expenditure averages about 1700 million DM (period 1994 to 1997).

The most significant programmes covered by the national plan can be summarized as follows:

Space Science

The extraterrestrial basic research programme of the German Government comprises projects of astronomy/astrophysics and solar-terrestrial relations, with the subareas of aeronomy, magnetospheric and plasma physics as well as planetary and cometary physics. The objective of this programme is the continuous promotion of space science in Germany through a national programme, through participation in the ESA space science programme and in bilateral projects as well as support for in-house initiatives of the research institutes.

The well-balanced mixture of short- and long-term activities takes account of the special structure of the German scientific community. Besides most of the national, international, and ESA projects with their comparatively long durations, special attention is given to short duration sounding rocket programmes and the use of Space Shuttle compatible reusable platforms (ASTRO-SPAS) for the training and teaching of junior scientists at university institutes. As a primary characteristic all activities contribute to the acquisition of new findings in basic research.

In the area of atmospheric physics, efforts are made to study and understand the structure and dynamics, and the energy budget of the Earth's atmosphere. For this purpose mainly sounding rockets (e.g. DYANA) are used, but also satellites and platforms (e.g. CRISTA-SPAS). Special scientific goals are in-situ measurements of the upper and middle atmosphere.

Main emphasis of planetary and cometary research will in future be on in-situ investigations and return of matter to Earth (MARS-94/-96, GALILEO, CASSINI, CNSR). Preferred objects of observation will include the planets Mars, Jupiter, and Saturn with their moons as well as asteroids and comets.

In the last few years, astronomy has been the key area of extraterrestrial research. Besides specific instruments (e.g. ORFEUS-SPAS, GAUSS/D2), the tendency to operate new observing systems (HST, ROSAT, GRO, ISO, AXAF, XMM) will grow. Observations will cover a wide frequency sepectrum ranging from radiowaves to gamma rays. High-energy processes (quasars, black holes) as well as areas of new stars birthplace, large-scale structures, big bang and other cosmoiogical aspects will be of primary scientific interest. The scientific output will decisively depend on coherent long-term investigations in all areas of the electromagnetic spectrum and between spaceborne and groundbased observatories.

The national programme concentrates on the supply of instruments for the multitude of scientific activities and on the supply of additional flight opportunities through participation in international projects such as the Hubble Space Telescope, through national long-term projects such as the x-ray satellite ROSAT, through bilateral long-term projects such as the GALILEO mission to Jupiter, and through the realization of short-term missions, e.g. with sounding rockets and platforms (ASTRO-SPAS).

Main events of the year 1993 were the fly-by of the GALILEO-spacecraft at the asteroid Ida (the second asteroid fly-by of GALILEO and the second ever performed by a human-made probe) in August and the mission of the Astronomy Shuttle Payload Satellite ASTRO-SPAS with its main instrument ORFEUS in September. ORFEUS gathered data in the far and extreme ultraviolet spectral range with which hot sources in the sky, generally called the birthplaces of stars, are investigated. This was the first of four ASTRO-SPAS-flights scheduled for the next few years. Another highlight was the flight of the GAUSS wide angle camera onboard the Spacelab mission D2, which adduced extensive pictures of the milky way and the Earth in different wavelengths.

Earth Observation

Reflecting its enhanced priority within the German space programme, the budget for Earth observation will increase significantly in the next years ahead. The national Earth Observation Programme is divided into contributions to national and multilateral projects, and to projects within the frame of European organisations such as ESA, EUMETSAT, and the European Union. The German national effort gives equal emphasis to scientific research and operational applications and specific utilization. It is designed to be complementary to the ESA Earth Observation Programme, but concentrates on projects of high interest to the German scientific and user community. Currently, active projects centre on instrument development, flights, and data exploitation. There is a need for a broadly defined European and international policy in this field. Important projects are the Scanning Imaging Absorption Spectrometer for Atmospheric Chartography SCIAMACHY (in cooperation with the Netherlands), the microwave sounder MAS as contribution to five of the American ATLAS missions, the Synthetic Aperture Radar X-SAR (in cooperation with Italy) as contribution to three Shuttle missions with the Shuttle Imaging Radar SIR-C of NASA, the scanning radiometer instrument ScaRaB (in cooperation with France) to be flown on the Russian Meteor satellite together with the Precise Range and Range Rate Equipment PRARE, the optoelectronic scanner spectrometer MOS and the high resolution multispectral camera MOMS-02 onboard the Priroda module which will be attached to space station MIR in 1994. With regard to the utilization of Earth observation data Germany seeks to involve the future operational users at an early stage of project development in order to allow for a demand pull rather than to define the

needs from the spacecraft engineer's point of view. Pilot projects and demonstration projects are well used vehicles for fostering Earth observation applications and data utilization.

Main events in 1993 were the flight of the MOMS instrument onboard the German Spacelab mission D2 in April 1993 and the second re-flight of the MAS instrument onboard the Space Shuttle in April 1993.

Research under Space Conditions

Major projects of the German programme on research under space conditions, especially in the field of microgravity research for material and life sciences and processing technology, are the national spacelab missions D1 and D2, the bilateral mission MIR-92 with Russia and other flight opportunities on MIR, and international missions like IML-1 and IML-2, as well as the fully automated flight of the microgravity platform EURECA. A focal point of the national programme is preparatory laboratory research and short-term flights, such as drop towers, parabolic flights, sounding rocket flights (TEXUS/MAXUS), and balloon flights (MIKROBA). The participation in the multilateral IML-1 mission in January 1992, the flight of a German astronaut onboard space station MIR in March 1992, and the highly successful flight of the national Spacelab mission D2 (in cooperation with NASA) in April/ May 1993 are three milestones in Germany's long history of activities in the field of microgravity research. It is expected that big projects in microgravity research on almost national footing have ended with D2. Subsequently, projects of this kind will be realized as cooperative programmes both for development and flight. Increased emphasis is put on the use of MIR as, for example, a good focus for a space medicine programme with a relatively short lead time.

Besides the D2-mission main events of the year 1993 were the continuation of German experiments onboard MIR, two TEXUS- and one Mini-TEXUS flights, the start of a Russian FOTON re-entry capsule with German experiments and the foundation of two German centers of excellence, adressing radiation health and closed biological aquatic systems.

Telecommunications/Navigations

The German national programme concentrates on future basic and user-oriented developments and pilot-projects in the fields of broadcasting, mobile communications, communications between satellites in orbit, and satellite navigation services. High priority is given to technologies which allow for reduced consumption of power and frequencies, and economic production techniques. Important projects in the time frame until 1995 are the development of controllable planar antennas for mobile communication via geostationary and other satellites, improvement of transmitter technologies, and special developments supporting the enhancement of the communication infrastructure in Eastern Europe. Focal points are studies and analyses on user needs and system requirements, as well as the development of small Earth communication spots (V-SAT), and development and test of an optical communication system (SOLACOS) with lasers for high data rate communication between satellites. With respect to a field of special public and commercial interest, satellite navigation, Germany aims at the demonstration of relevant applications using the American GPS (Global Positioning System) satellites and the russian GLONASS system. These techniques are improved by the development of differential measurement techniques and the combination of the GPS and the GLONASS system. Important successes to be mentioned in this context are the establishment of a worldwide Distress Radio Call System (DRCS) - water-buoys equipped with a GPS receiver and a INMARSAT transmitter - for emergency help in cases of ship accidents, and the demonstration of the use of navigation satellites for airplane landing systems.

Studies and Technology

Germany's national programme comprises a programme line which deals with new basic and applied technologies and with strategic studies. Projects of this line are intended to support the larger space

programmes by accompanying technology studies and technology development and demonstration projects. Efforts in the field of new technologies will render future projects possible and support the ongoing programmes. Furthermore, funding is made available for small and medium-size companies to support their specialized engagement and to contribute to their efforts in commercializing developed technologies and products. Another comprehensive task of this programme line is to apply product assurance to space projects. Also worth mentioning are the strategic studies carried out in order to provide a rational basis and sound back-up for Germany's space policy.

Orbital Infrastructure

The national activities in the field of orbital infrastructure are harmonized with the respective activities of the European Space Agency and are tailored to support and strengthen German industry's involvement in the European programme. In this area, national resources are concentrated on in-orbit servicing (mainly automation and robotics and rendezvous and docking), on small satellites, a small capsule for tethered re-entry and a limited effort for technology developments related to orbital and transport systems and re-entry.

The re-entry capsule, named EXPRESS, is a bilateral cooperation project with Japan which includes significant contributions from Russia and Australia. Germany provides the capsule on the basis of existing Russian technology and construction elements. It will be launched on a Japanese launcher in 1994 and after a mission time of a week EXPRESS will land at the Woomera test range in Australia.

The Hypersonic Technology Programme

Phase I of the German Hypersonics Technology Programm (HTP) was initiated by BMFT in 1988 and has been extended until the end of 1995. The SÄNGER concept of a two-stage winged space transportation system with air-breathing propulsion in its first stage remains the reference concept while technology developments are performed within a broadened spectrum. Although SÄNGER is continuing to be the technical reference concept, the developed technologies are applicable to a wide range of potential future space transportation systems. At the end of Phase 1 major enabling technologies in the areas airbreathing propulsion, aerothermodynamics, propulsion integration and materials and structures should be available together with an appropriate technology development and verification concept in order to provide an adequate basis for Phase 2.

Due to the fact that the development and implementation of an advanced space transportartion system will not be feasible within a national effort, Phase 2 is planned to be conducted within a European or international programme, which will contain further technology developments and dedicated ground and flight testing. Currently Germany is planning to participate in the first Phase (1994 - 1995) of the new ESA Future European Space Transportation Investigation Programme (FESTIP), which is expected to provide in the second Phase (1996 - 2000) a sound basis for the continuation of German hypersonics technology activities in an European frame.

Together with national programmes in Germany, France, United Kingdom and the Netherlands it is expected that Phase 2 of FESTIP will merge into a joint technology programme with a comprehensive international cooperation.

Ground Facilities

As a result of the evolutionary process and Germany's engagement in space activities and programmes, a significant national ground infrastructure already exists in the field of test and operational facilities. The following are only a few examples, as a complete listing of all German facilities would be too

extensive: the German Space Operations Centres (GSOC) at Oberpfaffenhofen; data transmission ground stations at Weilheim; various rocket engine test facilities at Lampoldshausen; wind tunnels, astronauts education and training facilities and large-scale material and structural test facilities at Munich; as well as various specialized laboratories. Other ground facilities which are in line with European activities, particularly to serve the envisaged orbital space infrastructure, are under construction.